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THE DIGESTION AND DILUTION OF COW'S MILK, IN THE ARTIFICIAL FEEDING OF CHILDREN.

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The main factor in the problem of artificial feeding of children is now, as it has ever been, the digestibility of cow's milk.

Great stress has been laid upon casein, as the offending ingredient; hence have arisen various methods of rendering it digestible. It is my purpose, this evening, to briefly review the current truths and falsities as to casein—what has already been accomplished (notably within the last twenty-five years) towards a judicious use of cow's milk, and to deduct conclusions.

Milk is composed of water, casein, butter, sugar and salts. These ingredients vary in quantity and mutual relations under various circumstances. In winter water diminishes, butter increases. In summer water increases, as also do the solids—casein, sugar and salts. In dry weather the quantity of milk is less, but the quality richer. "The afternoon milk is richer by one-quarter, on the average, than the morning's, and the last portion of a milking—the strippings—is the richest."

As Affected by Food.—"As long as the food of the cow is sufficient, nutritious and digestible, milk exhibits great constancy of composition, the variation in the diet showing itself in the quantity rather than the quality," says Franklyn. "Carrots increase the sugar, and slightly diminish the amount of casein and butter." (Report of Mass. State Board of Health). Beets and fresh foods increase the amount of sugar. "Cabbage, onions, turnips, saffron, wormwood, madder, fallen and decayed leaves, impure drinking water, may render the milk indigestible for the child, by changing odor, taste or color. Insufficient diet produces impoverishment in the solid materials. Brewers' grains rank under this head, when given as the main food, and are of service only when mixed with meal, hay, etc.

"Fermented food is totally unfit. Yet sour garbage and brewers' grains are much used in and about cities. Distillery slops, by stimulation, increase the quantity of milk, sometimes to a very large amount; yet, according to Dr. Edward Smith, the milk is incapable of producing cheese or butter, so deficient is it in albumen or oil. He found in a number of samples, with a specific gravity of from 1013 to 1024, 3½ to 6 per cent. of cream, and 4 to 8 per cent. of casein, as compared with samples of country milk, specific gravity 1026 to 1030, 7 to 10 per cent. of cream, and 9 to 12 per cent. of casein." Distillery milk fills out the body of the child as distillery slops bloat that of the cow; but it is a question whether there is *healthy* growth.

City Milk.—The milk supplied in cities, according to investigations made in Boston, in 1873, by the Massachusetts State Board of Health, and in Brooklyn, by the City Board, in 1876, contains of fat 2.80 per cent. to 13 per cent.; of casein and salts, 3.66 to 12.9; when it is generally conceded by authorities, in good milk cream should not be less than 9 per cent. nor the solids than 12. These investigations show, as others have before,

1st. That the main adulteration is water, 10 to 25 per cent. According to Prof. Chandler, the average milk furnished in New York city contains one quart of water to every four of milk. This adulteration is governed by demand and supply.

2d. That there is no mutual diminution or increase between cream, casein and salts in the various specimens of milk.

3d. That a large amount of cream is *no* indication of the greater richness of milk. The sample of milk containing 13 per cent. of cream was diluted 25 per cent., while another, showing only 4 per cent. cream, was diluted 10 per cent. Cream rises from diluted milk with much greater facility than from that which is pure; generally all has risen by the end of 24 hours, while in pure milk cream continues to rise for several days.

4th. That a small amount of cream is often accompanied by a large amount of casein and salts. Hence poor milk may need more dilution than good, on account of an excess of casein. Very rich milk may need it, owing to an excess of fat. The average pure milk may need it, owing to an inherent or acquired inability in the child to digest it without.

CHANGES IN MILK.—Fresh, *warm* milk is generally acknowledged to be most easily digested, owing to its retention of its unexplainable life principle, and the fact that it is quite thin, thickening as it cools. Artificial warmth will not restore this life principle, but it will, in a measure, thin the milk to its former consistency. Mr. Cleaver, Assistant Demonstrator to the Pharmaceutical Society, Philadelphia, states "that six hours after milk is drawn from the cow is the latest time, upon the average, at which milk should be analyzed, for then the natural changes of fermentation and putrefaction *begin* to be perceptible." "These are hastened by an atmospheric temperature of from 66° to 68° F. and above, and are retarded by a temperature of from 43° to 44° F." (Chevalier, Dict. of Adulterations of Elementary Substances). Electrical changes in the atmosphere, jolting, the presence of even the slightest particle of fermenting matter, hastens them.

CASEIN is soluble in fresh milk, and insoluble in that which is "turned." "Warmth, and contact with the smallest quantity of milk already changed, favor its coagulation, though it is not coagulated by heat alone, but by rennet, gastric juice, alcohol, tannin, and a number of salts, by vegetable and mineral acids, especially if milk is heated to about 75°." Pepsine coagulates but slightly. Mixed milk, containing colostrum, will sometimes be coagulated by heating. So will heat sometimes cause milk to which adulterating substances have been added to precipitate, in a semi-solid mass, its coagulated albumen, entangled with the adulterations. Boiling thins milk, breaks up some of the fat globules, renders others lighter, but carries with them some of the casein. It drives off the contained air, which Dr. Jacobi believes to be the cause of acid fermentation of milk. After boiling, the doctor removes the coagulated film, as the cream has been removed before. It has always seemed best to myself to thoroughly stir in the filmy coating of albumen, cream and casein. Boiled milk answers well in diarrhœa, and scalded in constipation. "Rennet does *not* coagulate boiled milk either as promptly or completely as normal milk, under the same conditions." (Chevalier). The throwing down of casein carries with it cream, so that any attempt to remove casein removes cream.

The hardened fæcal passages not uncommon in children in our cities, fed mainly or entirely upon milk, are caused, according to most writers, by the quantity of casein in cow's milk. It is quite as often due, as was

pointed out by Dr. Coley in 1846 (Diseases of Children), to a deficiency of sugar, albumen or oil. Yet it is true that a surplus of casein is generally accompanied by a diminution in sugar. If casein is always the offender, how can we account for the good results obtained by Dr. Simington, of Danville, Pa., (see Trans. Med. Soc. of Penn., 1875), by the use of buttermilk in severe diarrhœas of children?

Again, during dentition the intestinal secretions may be in excess, and produce diarrhœa and indigestion, or from slight causes a catarrh may be set up, with like results, or a *decrease* in the digestive secretions not uncommon at this period, with a diminished peristaltic action, may not be able to cause assimilation even of a normal amount of casein.

As Dr. Logan, of Kentucky, writes: "The digestibility of milk depends more on the *quality* than the quantity of casein." The milk of some women is bulky, and naturally as indigestible as any specimen of cow's milk can be. The milk of sickly, ill-nourished women or of those advanced in life is likely to be.

Different Modes of Dilution.—Water. The addition of water alone, says Routh, favors the *separation* of casein and renders it harder. In some experiments I found this to be the case. In many cases, Jacobi's method of feeding will answer, viz., giving sweetened water, oatmeal or barley, as the case may be, before feeding, or, if the casein does not all digest, then adding mucilage, with sugar and salt, and antacids if necessary. Yet there are children whose stomachs revolt against barley, oatmeal, mucilage or boiled milk. This method of dealing with cow's milk claims, as do all others, that the milk is held in suspension, and the casein rendered lighter and more flocculent.

Lime-water has for a long time been in use, but in the practice of many it has failed. From various parts of the country physicians who use it write—when necessary, or if there is acidity.

Dr. E. N. Chapman, in a series of able articles published in *The Sanitarian* during the latter months of 1875, claims for his method of one-sixth lime-water wonderful results.

"Take condensed milk two teaspoonfuls, water 24 (or, if plain milk is used, water ½), lime-water 4, powdered sugar ½ teaspoonful, and a small pinch of salt. Bring the water to a blood-heat, measure the milk accurately by pouring from one spoon to another. Mix and stir the several ingredients together." He concludes that the good results "are not due to any alkalinity, but to the fact that the casein is held in emulsion, that the salt aids the stability of the emulsion, and the solution of the casein. I have used this method with some good results, yet one child vomited it whenever given. In this family of five children, none had ever been able to retain even the smallest quantity of lime-water."

Eustace Smith says one-third of any milk mixture should be lime-water. Routh advocates half ounce to half pint of cream and water. It is used by physicians throughout the country in from one-fourth to one-tenth.

Other Alkalies.—From experiments, I found that pot. bi-carb., added to milk in a summer temperature of 75° F., produced a hard, firm clot in a few hours, while sodæ bi-carb. formed one less firm, which was longer in its formation.

Prof. Buckingham, of Harvard, and others, find that practically pot. bi-carb. is the more suitable alkali. He prefers it to lime-water, and writes: "Add pot. bi-carb. 1 or 2 grs. to each ounce of milk, and dilute with water till proper dilution of milk is gained, as the same child would be likely to starve on milk which it does not digest. Then the addition prevents milk from souring for 24 hours, and renders the curd softer, like human." "The addition of soda to milk will not prevent the escape of the volatile acids when heat is applied," says Mr. Cleaver.

Pepsine fails in the hands of many, either acting feebly or coagulating into firmer clots. In such cases it may be a poor article, or needs an acid yoke-fellow, as we find in gastric juice. Pepsine, muriatic acid, glycerine and water is an excellent preparation.

Glycerine.—Recommended by Dr. Channing to be used instead of sugar as an addition to milk, is of value, is bland, readily absorbed. For the first month of life he adds four drachms of glycerine to one quart of cream and water. Between the second and third months he gradually substitutes milk for cream, two parts, to water one part, if the child does not need the cream to fatten upon. At six months he gives pure milk.

Two propositions of late years exciting great interest are: First, the one to add cream or fat to milk as a corrective; and, second, the one by Dr. Hiram Corson, of Pa., to give whole milk.

Cream.—Much has been written against the use of fat, its indigestibility—yet in defective nutrition, and in weakened powers of digestion, cream ol. morrh., fat and butter, if given in sufficiently small quantities and at proper intervals, will be more readily digested than other forms of food.

Various methods are resorted to by advocates of cream.

Dr. F. K. Bailey, of Knoxville, writes: "I have carried out the practice for forty years without variation of giving cream one-third, and sweetened water two-thirds. Dr. Jones, of Toledo, uses cream, one part; sweetened water, four or five parts.

It is the custom here, in Tuscaloosa, Alabama, writes a physician, to use two-thirds water with cream, but I like one ounce of cream and one of

aq. calcis. Some years ago Dr. Cummings, of Georgia, published a pamphlet describing an excellent method of preparing milk. I am sorry that I do not have it at hand to quote from, as the pamphlet had, I believe, a limited circulation.

Any proposal to remove, first, the cream, then a part of the casein of milk, and then to return the cream, is not a reliable one, for casein and fat are so intermingled, that the removal of one carries the other, in part, with it. Then all milk is not the same milk. The milk of the Alderney cow will yield from 30 to 40 per cent. cream; Jerseys, 18 to 20; Devon, 17 to 18, etc. Other milk, as that from the Durham breed, is rich in casein mainly. Distillery milk shows much cream, and is poor milk.

Very rich milk may not be the best for the child. From such milk remove one-third cream or dilute with one-fifth water, or more, if necessary. If the milk has an excess of casein, it is much more rational, as Dr. Dawson has suggested, to add cream or fat than water. The severe cases of constipation, caused by such milk, are best remedied by the addition of cream or oil, or by giving child, if old enough, fat meat to suck.

The latest proposition is to add one scruple of ol. of sweet almonds to every two ounces of milk.

Other Additions.—Some of the old writers advised different preparations of farinaceous food—arrowroot, corn-starch, etc.—to be added to milk. Though not now recommended, yet we find the two combined in use in many families, and apparently with good results. The nitrogenous foods answer a better purpose in the majority of cases.

Gelatine.—Similar in its action and properties to gum arabic is gelatine. Dr. Meig's Gelatine Food, prepared with cream, still retains a prominent place in the dietetics of infancy, though, like all other foods, it is not a panacea.

Salts.—It is worthy of note that in all the differences of opinion as to food, chloride of sodium is looked upon generally as a necessary addition.

Some go further, and believe that the phosphates are necessary in some form, especially in children who do not thrive upon their cow's milk, or to be added to the milk of cows fed upon poor pasturage, or when the milk lacks salts.

The plan of Dr. Wiggins, of Providence, which has been quite largely used, is as follows :

Commence with one part of milk and two of water, add cream from a quantity of milk equal to that of the water added ; also add a pinch of the phosphate mixture, and 40 grains of milk sugar to each meal.

Dr. Wiggins' Phosphate Mixture :

Phosphate of lime, . . .	4 parts.
" " soda, ...	½ "
Hypophosphate of magnesia,	½ "
Chloride of sodium, . . .	2 "
Carbonate of potassa, . .	2 "

The first week's feeding, writes the doctor, often decides the fate of the child. I gradually increase the quantity of milk. Warm fresh milk is successful with children of fair digestive powers, and is much resorted to in the country.

WHOLE MILK.—That this last statement is true, is evident to any one who has seen it tried, or who has had occasion to feel grateful for the ease with which some babies will digest *pure* milk, even in the city, when all other foods have failed ; but it *should be* good, wholesome milk.

A baby born dyspeptic, whose mother was of nervous temperament, not able to digest the mother's milk, notwithstanding all care taken to assist the child and remedy the curdling of the milk—rejected milk diluted with water, mucilage, barley, oatmeal, etc. Liebig's, Imperial Granum and Cereal Food, with what cream could be obtained, was digested. Going to the country at four months of age, although the mother had been advised to give warm fresh milk, she diluted it, without success. The child then took fresh warm whole milk, and thrived ; coming home, it did well on whole milk here, even digesting it cold, though when cold there seemed more of a tendency to constipation.

The milkman's route being to another, the child did not do so well as before and was very constipated, passing hardened fæcal balls. An examination of the milk showed it to be much poorer in appearance than the preceding milk, having less cream, and containing over one-half in bulk of casein.

Dr. Corson's faith and practice grew out of the belief which many share to-day, that underfeeding is the prevalent evil—that filling the stomach merely is not affording nourishment. We are to ask ourselves, in each individual case, the question:

Does the food administered contain all the elements of nutrition in such form and quantity that they may nourish the child, through a painless, prompt and easy digestion ? as well as the second one:

Does it contain anything injurious, or that cannot be digested ?

Eustace Smith has pointed out the great difference between proper and improper artificial feeding, claiming that with the first there is as great success as when children are nursed. Dr. Corson but echoes this when he writes : " I feel quite certain that it is almost as easy to

raise children by hand, if they have an abundant supply of good whole milk, as it is by the breast. The plan of diluting milk with water is 'starvation by prescription.' Uses no other milk but cow's milk, either given fresh, or after it has stood in a cool place in the cellar—have raised nine children of my own on whole milk, and have an experience with whole milk of over forty years." In a letter he relates the following case, which, for lack of time, and from a fear of tiring your patience, I am compelled to give an abstract of: "Child, æt. six months, bottle fed, dilute milk, brandy, blood, etc., reduced to 4½ pounds in weight—pronounced to be a case of hopeless marasmus. I ordered, without regard to consequences, a tablespoonful of whole milk to be given every hour, and to increase the quantity, as soon as possible, to as much as it could take. The first dose it rejected immediately, a part of the second, and retained the third. In a week it ceased to moan, showed improvement, and went steadily on to grow and fatten. It is now a chubby, healthy child of four years."

It is not necessary, writes the doctor, to have the milk from one cow, if it is inconvenient to get it; the ordinary run of mixed milk from a good dairy may be used to advantage.

Condensed milk, though useful, does not in reality represent the mixed fresh milk from a good dairy, any more than canned meat extracts represent the fresh juices of fresh meat. The ordinary mixed milk of the cities may not be digested, for various reasons, as we have already seen.

The rules of the Obstetrical Society of Philadelphia, issued a few years ago, for the management of infants in the hot weather, convey the same meaning.

"If the milk is known to be pure, it may have one-fourth part hot water added to it; but if it is not known to be pure, no water need be added. When the heat of the weather is great, the milk may be given cold. Do not skim the milk. In very hot weather boil as soon as obtained, and then place in cool place. Whenever pure milk cannot be obtained, give condensed milk."

Dr. Logan, of Shelbyville, Ky., writes: "Don't dilute at all. Numbers of children in this section are raised on pure warm milk, and fully three-fourths of them live as long and prosper as much as when nursed. He lays great stress, as we all may with advantage, on the importance of keeping the body cool as an element in aid of digestion."

Prof. Byford says: "We consider fresh milk, drawn but a few hours, and from one cow, better than that mixed. Let it stand in a deep, narrow vessel for about three hours in a cool place, then pour off the upper two-thirds for use in summer. Under four months add lime-water, if

tendency to acidity, and soft water if no such tendency. If diarrhœa, boil before diluting."

From Greensboro, Ala., comes the statement, that warm fresh milk is used here, and seemingly with as good success as by any other method, selecting, if possible, cows with the youngest calves.

Prof. Goodell writes that warm milk is not used in Philadelphia, as a rule, because it cannot be obtained.

In Schenectady, *cold* fresh milk used with success.

Dr. Thayer, of Binghampton, writes : "We use milk, undiluted. It cannot be improved by diluting."

Dr. Hamlin, of Bangor, *knows* that artificial feeding with whole milk is successful there, if swill milk is not used. It may be given cold or warm.

It is curious to note that in Columbus, O., Reading, Pa., and Athens, Ala., and other cities of the country, pure milk is given after the first month, or second, or third.

Experiments.—The following is an abstract of such points, in experiments made last summer, as bear upon the preceding remarks: 1st, With distillery milk, obtained from the distillery at Blissville; 2d, With milk from cows fed mainly on grain; 3d, Garbage milk, or the milk from cows fed on table refuse; 4th, Park milk, obtained warm from the herd at Prospect Park; 5th, Milk from Rushmore's depot; and 6th, Milk from an ordinary second-hand corner grocery among the tenement houses.

Rushmore and Park milk threw up same quantity of cream; grocery and grains nearly as much; while distillery milk gave twice as much cream as garbage, and four times as much as the grocery. The reaction in all was slightly acid. It will be remembered that it has been contended that good milk should be alkaline, or neutral. It is now known that a slight acidity, or ranky alkalinity, is not out of the way. Decided acidity shows fermentation, while strong alkalinity shows the milk to be doctored or diseased.

Specific Gravity.—At 60° F., grocery milk stood 100 by lactometer; distillery, 95; Rushmore's, 105; grains, 102; garbage, 88, and Park, 110.

Time of Separation of Ingredients.

Grocery.—On Fourth day, little whey, upper half in tube separating, lower half solid.

Distillery.—Two-thirds whey, separated in 24 hours.

Rushmore's.—Five days separating in flocculi, little whey.

Grains.—Same as Rushmore, with more whey.

Garbage.—In four days, long, putrid, flocculent masses.

Park.—On fifth day, just beginning to separate.

In a second set of experiments whole milk was compared with milk diluted with water.

DISTILLERY.—Whole, in open filled bottle, and acid in four hours, separated in 18 hours. Whole, in closed filled bottle, the same.

GROCERY.—Both lobbered in 17 hours, separated in five days.

GRAINS.—Both lobbered in 17 hours, separated in 21 hours.

RUSHMORE'S.—Both lobbered in 17 hours, separated in 25 hours.

PARK.—Both in 17 hours acid, lobbered in 21, separated in 33.

GARBAGE.—Both separated in 17 hours.

DILUTED WITH WATER.—One-half, one-third, one-fourth and one-fifth, distillery, in four hours and acid; respectively, one-half, one-third, one-third and two-thirds whey, separated in 13 hours.

GROCERY.—All sour in 17 hours, separated in 22 and 42 hours, and four days and four and one-half hours.

GRAINS.—First three separated in 20 hours, one-fifth water in 25 hours.

RUSHMORE'S.—First separated in 24 hours, rest in 30 hours.

PARK.—All separated in 21 hours.

GARBAGE.—All separated in 20 hours.

Lime-water added in proportion of one-half, one, two and three teaspoonfuls to milk two ounces, did not delay souring.

We conclude that if cow's milk does not agree it is owing:

First. To some inherent or acquired cause in the child.

Second. To the natural condition of the milk.

Third. To some acquired condition—by fermentation, putrefaction, growths or adulteration.

It is not chimerical to hope that Boards of Health, Medical Societies, Societies for the Protection and Care of Children, will, in the future, give as careful attention to the feeding of children as stock-raisers throughout the country are bestowing upon the foddering of cattle.